PAGETIA OCELLATA, A NEW CAMBRIAN TRILOBITE FROM NORTH-WESTERN QUEENSLAND

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ABSTRACT

The first description of a new Australian eodiscinid trilobite since 1902 is accompanied by a detailed description of the recognized growth stages. This growth series for *Pagetia ocellata* sp. nov. is the first described for any species of the family and compares closely with those of agnostids. The species closely resembles the North American *P. walcotti* with which it is compared.

Only one species of eodiscinid trilobite, *Pagetia significans* (Etheridge, 1902), has previously been described from Australia although several have been recorded without formal specific designation (Opik, 1957, 1957a, 1967). Collections from the Mount Murray area, northwestern Queensland, contain numerous individuals of a previously unmentioned species. Protaspides have not been identified, but the recognition of a complete series from degree 0 meraspides to mature holaspides has allowed a detailed study of the morphogeny of the species. This series is, to the author's knowledge, the first described for a pagetiid and is similar to the series of eodiscids (Rushton, 1966) and agnostids (Robinson, 1964). The material is from phosphatic limestone near the top of the Beetle Creek Formation 1.5 to 2 miles north of Mount Murray, 50 miles southwest of Duchess, northwestern Queensland. In this limestone the organic material, including the trilobite exoskeletons, has been selectively phosphatized. Removal of the matrix by dissolving it in monochloracetic acid, liberated the specimens.

All specimens used in this study are deposited in the palaeontological collection of the Queensland Museum, Brisbane. The locality number prefixed by L refers to a locality in the Queensland Museum locality catalogue and that prefixed by D to the locality of the Bureau of Mineral Resources as on the preliminary map (accompanying de Keyser, 1968). The terminology and suprageneric classification employed follow those of Howell (1959). The following abbreviations are used in the text: *Cl*, length of cephalon; *Cw*, width of cephalon; *Hl*, length of hypostoma; *Hw*, width of hypostoma;

Ll, length of librigena; *Lw*, width of librigena; *Pl*, length of pygidium; *Pw*, width of pygidium; *exsag.*, exsagittal; *sag.*, sagittal; *tr.*, transverse.

Class TRILOBITA Walch, 1771

Order MIOMERA Jaekel, 1909

Suborder EODISCINA Kobayashi, 1939

Family PAGETIIDAE Kobayashi, 1935

Genus **Pagetia** Walcott, 1916

Pagetia Walcott, 1916, p. 407; Whitehouse, 1936, p. 81; Howell, 1959, p. 0189; Rasetti, 1966, p. 502

TYPE SPECIES (by original designation): *Pagetia bootes* Walcott, 1916, p. 407, pl. 67, figs. 1, 1a–f; *Bathyuriscus–Elrathina* Zone, Middle Cambrian; Burgess Shale Member of the Stephen Formation, north of Field, British Columbia, Canada. Since Walcott did not designate a holotype, a re-examination of the syntypes (United States National Museum paleontological collection Nos. 62855–62861) should be attempted and a lectotype chosen.

DIAGNOSIS: Isopygous trilobite with two thoracic segments; cephalon with moderate relief; broad axial furrow defining somewhat tapered glabella behind a flat depressed preglabellar field; glabellar furrows shallow to obsolete; long horizontal to uptilted spine extending from the rear of the glabella and occipital ring; fixigenae elevated posterolaterally; palpebral lobes undifferentiated to fairly well defined by palpebral furrows; typical functional 'proparian' facial sutures steeply downsloping from the eye to the border furrow; narrow cephalic doublure; hypostoma present; pygidium with strong relief; segmented pygidial axis usually with five tuberculate rings and a spinose terminal section; pleural furrows evident or effaced; geniculation sharp with well developed facets; surface generally smooth sometimes punctate or granulate.

DISCUSSION: Walcott (1916) defined the members of the genus *Pagetia* as "the forms of Eodiscidae in which eyes, free cheeks and facial sutures are developed". This diagnosis is now used to define the family Pagetiidae while the above detailed diagnosis is applied to the nominate genus.

Rasetti (1966) pointed out that *Pagetides* Rasetti, 1945, was the only genus with which *Pagetia* might be confused. While the type species, *Pagetides elegans* Rasetti, 1945 from the Lower Cambrian of Quebec, is easily distinguished in having three thoracic segments, he differentiated between other species of the two genera using a combination of several characters. *Pagetides* has a strongly upturned cranidial spine, a well impressed palpebral furrow, a medially expanded cephalic border, indistinct or obsolete radial markings on the cephalic border, wide almost vertical pygidial doublure, and no caudal spine. Although the species described below has an upturned cranidial spine and well impressed palpebral furrows the combination of all the characters serves to exclude it from *Pagetides*.

The genus *Pagetia* has received a large number of species with widely varying characters and as Rasetti (1966) pointed out, separation of some at the generic level may be desirable. The species described below, along with other Australian species, may not in fact be attributable to either of Rasetti's suggested generic groups. However, at the present time it is practical to describe it as a member of *Pagetia*.

RANGE AND DISTRIBUTION: Species of *Pagetia* range through the Lower and Middle Cambrian and have been recorded from North America, Asia and Australia.

Pagetia ocellata sp. nov.

(Pls. 23, 24)

HOLOTYPE: F6323 from L113 = D640 on Duchess 1 : 250,000 geological map, (sheet F 54–6, Australian National Grid) 1.5 to 2 miles north of Mount Murray at approximately 21° 50′ south latitude, 139° 58′ east longitude, northwestern Queensland; Beetle Creek Formation, early Middle Cambrian. A ptychagnostid in the fauna at this locality suggests a position high in the Beetle Creek Formation, at the base of the *Ptychagnostus gibbus* Zone (Shergold, 1968).

MATERIAL EXAMINED: Several hundred dissociated cephala, thoracic segments, pygidia, hypostomas and librigenae including F6170 to F6326.

DIAGNOSIS: Eodiscinid with eyes and functional facial sutures reaching the margin at an acute angle; marginal extremities of the librigenae pointed; broad cephalic border ornamented with elongate radial pits that do not reach the margin; low, almost obsolete eye ridges present; tumid fixigenae; occipital, axial thoracic and caudal spines present; narrow pygidial border; five axial pygidial rings and terminal section; pleural pygidial furrows effaced or almost so; granulate dorsal exoskeleton; steep geniculation distant from axis; facets well developed.

DESCRIPTION: The carapace is oval, elongate sagittally. The entire dorsal exoskeleton has granulose ornament, but hypostoma and doublure are smooth. Rarely, specimens are found enrolled (pl. 23, figs. 6, 7).

The semicircular cephalon has a straight posterior margin. Numerous elongate pits normal to but not close to the margin ornament the broad cephalic border which narrows slightly posteriorly. The border furrow is wide and shallow anteriorly becoming narrower posterolaterally. Parallel to the posterior margin both the border and border furrow are extremely narrow. The straight-sided glabella is crossed by a weakly incised transglabellar furrow in front of which is a small anterior lobe which tapers rapidly forward. Two pairs of extremely indistinct lateral glabellar furrows are seen on the posterior lobe. The two lateral furrows on each side of the glabella arise out of long (exsag.) lateral con-

DERIVATION OF NAME: From the diminutive of the Latin *oculus*—the eye; *ocellata* refers to a small eye with many spots.

strictions of the posterior lobe. A small depressed preglabellar field separates posterolaterally tumid fixigenae which are crossed by eye ridges arising near the transglabellar furrow and finishing distally at the anterior of the palpebral lobe. A discontinuous occipital furrow is represented by two lateral notches low on the posterior glabellar lobe. The posteriorly directed, broadly based occipital spine which tapers to a fine extremity arises from the posterior glabellar lobe and occipital segment. The broad deep axial furrow widens posteriorly where it is confluent with the border furrow. At these junctions large low tubercles are situated within the furrow. There are no genal spines and the genal angle is truncated. Small well-developed palpebral lobes and furrows are present. These lobes accomodate slightly elongate (exsag.) schizochroal eyes each possessing approximately 20 lenses. Typical "proparian" facial sutures meet the margin anteriorly at 60 degrees and posteriorly at 40 degrees; these extremities are pointed.

The narrow doublure shows no trace of terrace lines. The rostral plate is unknown. Although a large number of hypostomas were found at this locality none were attached to the dorsal exoskeleton. The only species of which a comparable number of dorsal exoskeletons was found is the one being described, and the relative size, similarity to the other pagetiid hypostoma described (Opik, 1952), and size range induced the author to consider these hypostomas as belonging to the new species. Their anteroventrally convex anterior border is extended laterally into projections the distal extremities of which are not preserved. A shallow border furrow and narrow border are continuous around the margin except at the anterolateral corners. Maculae are represented by two small low tubercles just ventral to the border furrow and at the posterior of the median body. They are adjacent to slight irregularities at the lateral margin.

Two thoracic segments are present as deduced from morphogeny (see below); no articulated thorax is known. The pleural extremities of the anterior segment are curved slightly posteriorly and those of the posterior segment are curved anteriorly to facilitate enrollment. The well impressed pleural furrows are close to the posterior and anterior edges respectively. A transverse furrow separates the crescentic articulating halfring and the spine-bearing axial ring. The prominent posteriorly directed spine of variable size is apparently larger on the posterior segment since those attached to degree 1 meraspides bear the larger spines. The long (tr.) narrow (exsag.) pleurae are slightly expanded and rounded distally.

The semicircular pygidium is bounded by an extremely narrow border which widens anterolaterally, but narrows again parallel to the anterior margin. The border furrow is shallow and narrow posteriorly becoming deeper and wider anteriorly. The broad poorly impressed axial furrow joins the border furrow anteriorly but encompasses the rear of the axis as a discrete furrow. The axis consists of five rings each exhibiting a slight tubercle at its dorsal crest and a terminal section with a short (sag.), stout, dorsally and posteriorly directed spine. The short (sag.), high, articulating halfring preserved on the anterior margin resembles closely the agnostoid type (Opik, 1968). The pleural regions are only slightly tumid and interpleural and pleural furrows are effaced except for the anterior border

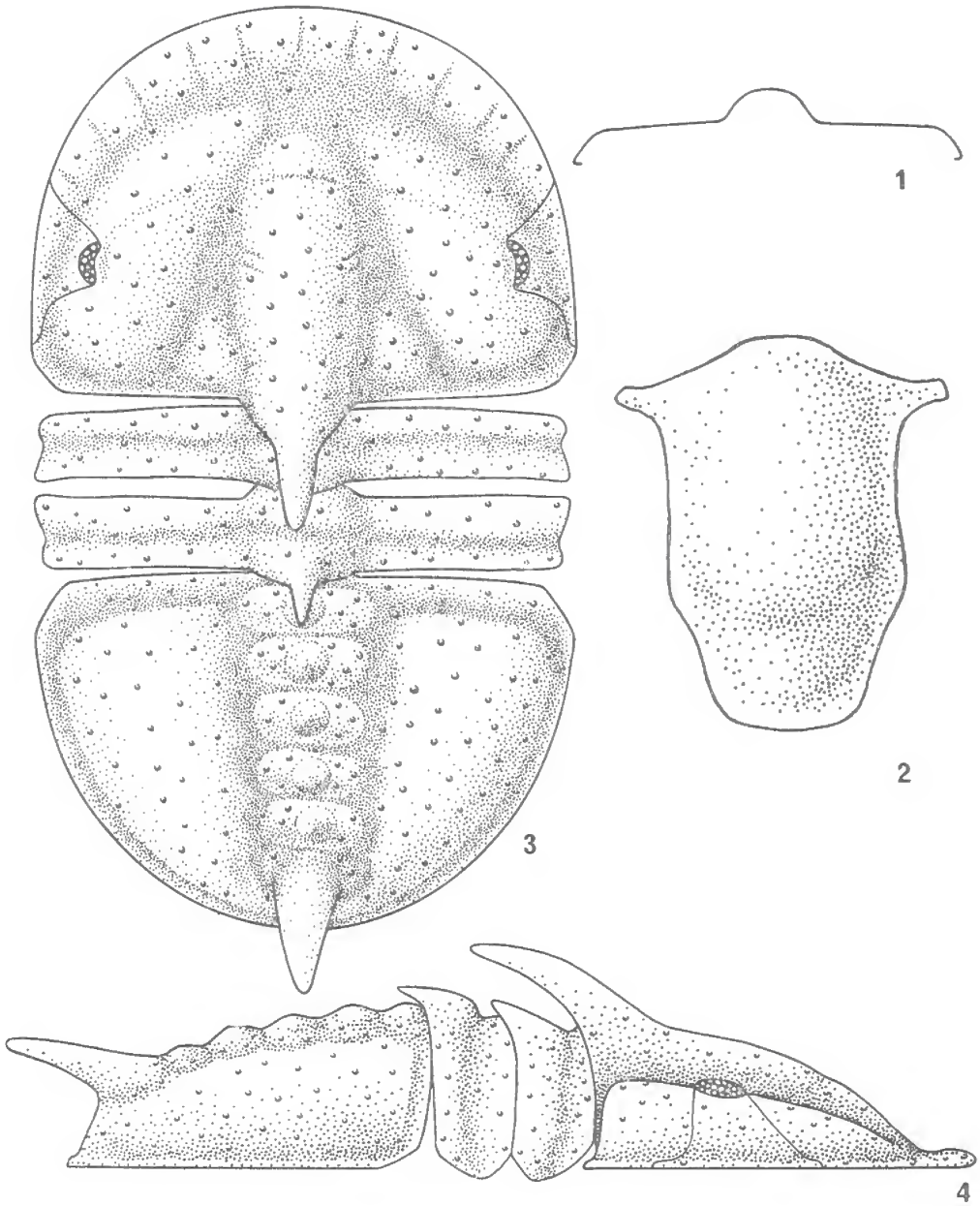

FIG. 1: *Pagetia ocellata* sp. nov. 1, section (tr.) of thorax; 2, ventral view of hypostoma; 3, dorsal view, with thoracic segments slightly separated; 4, right lateral view, with thoracic segments in articulating position.

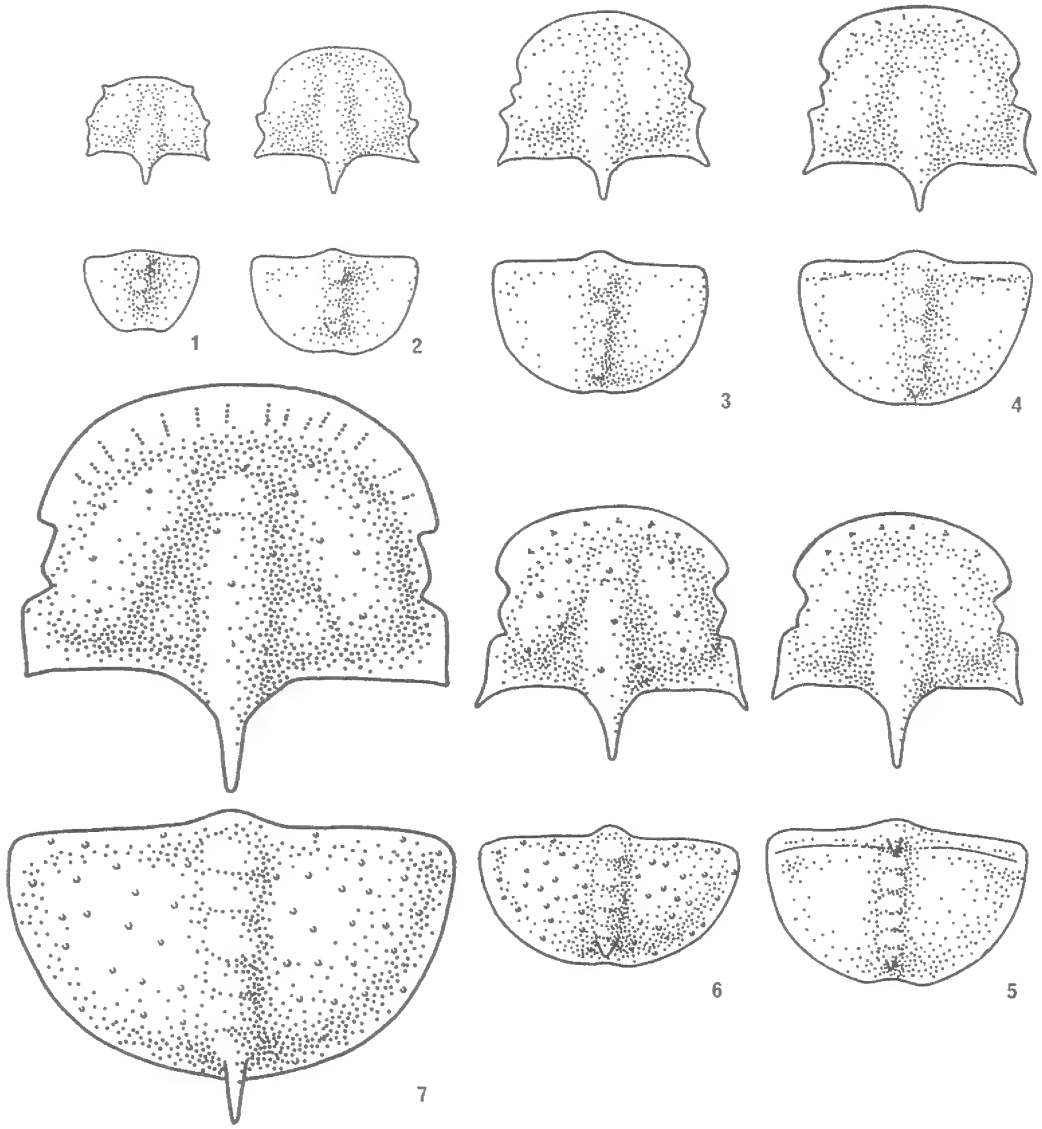

FIG. 2: *Pagetia ocellata* sp. nov. 1, degree 0 meraspid with three pairs of cephalic spines and three axial pygidial rings; 2, degree 0 meraspid with two pairs of cephalic spines and four axial pygidial rings; 3, degree 0 meraspid with five pygidial axial rings; 4, late degree 0 meraspid with seven pygidial axial rings and a slightly spinose terminal section; 5, degree 1 meraspid with six pygidial axial rings and a spinose terminal section; the spinose posterior thoracic segment is still part of the pygidium; 6, early holaspid with five pygidial axial rings and spinose terminal section; the small genal spines are still retained; 7, later holaspid without genal spines but showing elongate cephalic border pits, elongate caudal spine etc.

furrow which is a pleural furrow. Some specimens (pl. 23, fig. 25; pl. 24, fig. 21) exhibit faint pleural furrows with notches in the axial furrow at the proximal end. The fulcral points are distant from the axis and are steeply geniculate.

ONTOGENY: Protaspides have not been recognised to date. However, successive growth stages from the apparently early meraspid are represented. Normal size increase is accompanied by several morphological changes.

(1) Cephalic spines: Earliest meraspides have three pairs of spines—anterior and posterior profixigenal and genal. The genal spines are fine and short in meraspides, but absent in holaspides. Anterior profixigenal spines are present only in earlist meraspides. Posterior profixigenal spines are present in degree 0 meraspides. The profixigenal spines are extremely small and almost imperceptible.

(2) Shape of the librigenae: This changes as a result of change in position of the facial sutures. Elongate (exsag.) and narrow (tr.) in early meraspides, the librigenae become wider (tr.) until in holaspides they are subrectangular. Spines on the marginal extremities of the librigenae decrease in relative size with development.

(3) Relief on cephalon: Elevation of the glabella is very low in meraspides, but in later meraspides and holaspides the glabella and fixigenae are of similar elevation.

(4) Length of cephalic border pits: The cephalic border pits which first appear in developing meraspides do not become elongate until the holaspid stage is reached.

(5) Pygidial axis: The number of pygidial axial rings varies with development. Early degree 0 meraspides exhibit three. As the meraspid develops so the number of rings increases progressively until the last degree 0 meraspid has eight rings. Specimens have been found which exhibit each of the intervening number of rings. The degree 1 meraspides have seven rings and the holaspides six.

The thoracic segments are initiated anteriorly on the pygidium as indicated by an excess of pygidial rings in the late degree 0 and degree 1 meraspides over the number in holaspides and by the presence of transverse sutures on the anterior of the pygidium in meraspides (pl. 24, figs. 14, 15). The comparatively large spines on the anterior pygidial rings of meraspides become the thoracic axial spines when each thoracic segment becomes a discrete segment. Development of the spines in that region is therefore not haphazard as could be inferred if size of the spine and size of the pygidium were correlated, but is allied to the evolution of the thorax.

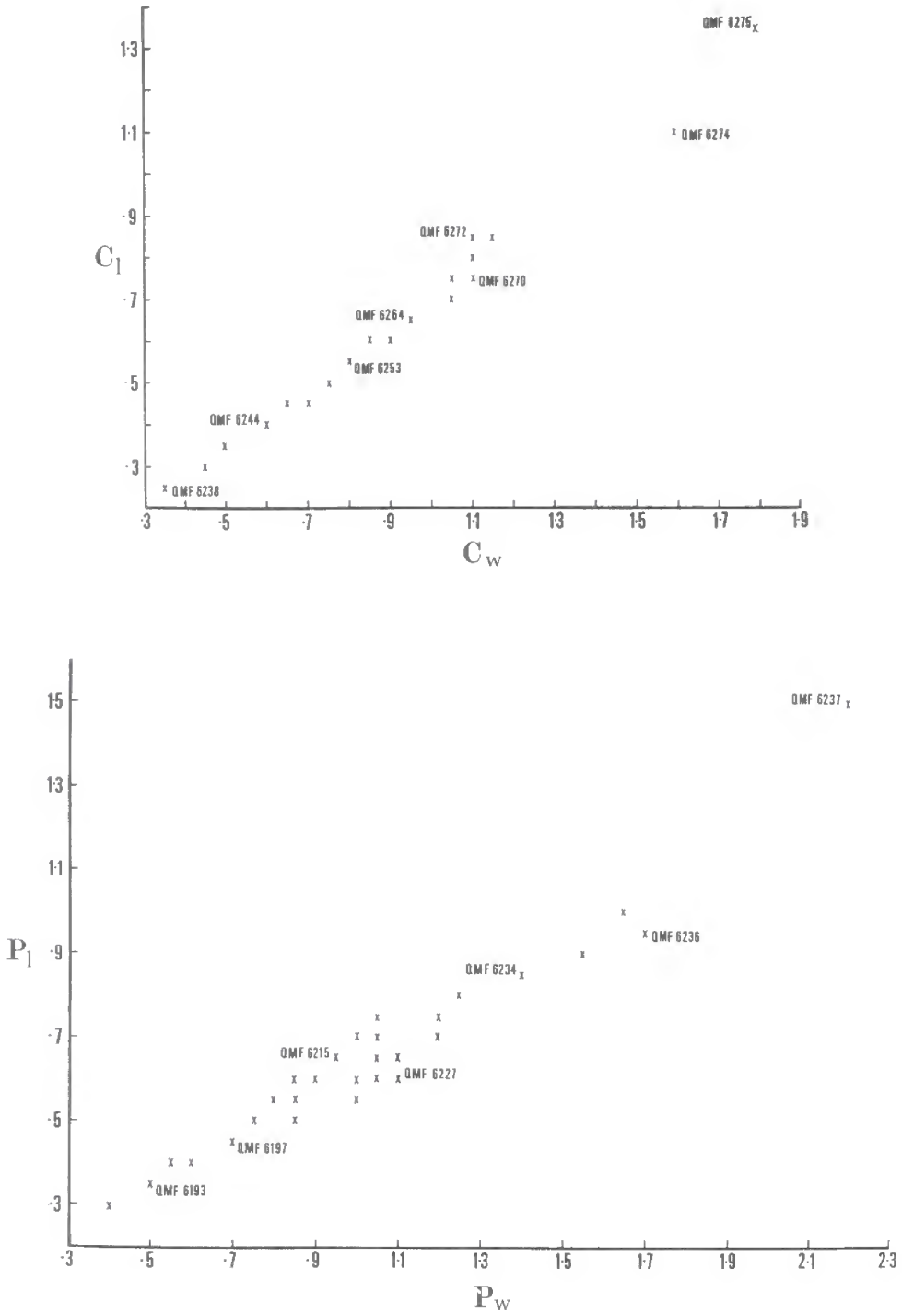

FIG. 3: Dimensions in mm of Queensland Museum specimens of *P. ocellata* sp. nov.

(6) Anterior pygidial axial spine: The anterior pygidial axial ring in meraspides bears a prominent spine while in holaspides it bears only a low tubercle.

(7) Caudal spine: The caudal spine is absent in degree 0 meraspides except where there are eight axial rings. It is present in all later stages.

(8) Width of pygidial axis: The relative width of the pygidial axis varies becoming progressively greater with development.

(9) Relief on pygidium: Relief of the pygidial axis decreases with development, the tubercles on each ring becoming less prominent and the axis fitting more closely into the general convex shape of the pygidium.

(10) Pygidial border: The pygidial border becomes progressively narrower from the meraspides through to the late holaspides especially between early and late holaspides.

(11) Ornament: The granulate ornamentation which is so characteristic of the mature holaspides is absent on all meraspides.

DISCUSSION OF MORPHOGENY: Matthew (1896, pp. 242–4, pl. 17, fig. 8d) described and figured a protaspis of *Microdiscus pulchellus* Hartt, 1884. However, from the figure and description, the specimen seems to be the protaspis of a polymerid trilobite and not an eodiscinid. Clark in 1923 described *Dipharus insperatus* as the type of a pagetiid genus but Shaw (1950) reinterpreted his material as the juvenile form of *Hebediscus attleborensis* (Shaler and Foerste, 1888). To the author's knowledge it is the only previous description of a juvenile pagetiid but does not include any recognition of the growth series.

In the absence of descriptions of the morphogeny of other members of the family the series described in the preceding section is compared to that of eodiscids as described by Rushton (1966) and agnostids as described by Snajdr (1958) and Robison (1964). The morphogenetic series of *Pagetia ocellata* described herein and those of eodiscids (Rushton, 1966) bear several striking similarities to those described for agnostid trilobites while agreeing fairly closely between themselves as well. The protaspid stage is apparently absent. The glabella of the early meraspides does not reach to the anterior margin of the cephalon. The pygidium and cephalon retain their comparative size relationship through meraspid and holaspid stages. The thoracic segments move forward from the anterior of the pygidium. Except for the last these contrast with those of polymerid trilobites and all four features confirm the close relationship of eodiscinid and agnostid trilobites.

Morphogenetic series of other Australian species have been observed and it is anticipated that their description will appear when further material is available.

REMARKS: Closely spaced granules over the dorsal exoskeleton serve to distinguish *Pagetia ocellata* sp. nov. from the Australian and Asian pagetiids. Several North American species exhibit this ornament and are comparable in other features as well. *Pagetia*

bigranulosa Rasetti, 1967, and *P. laevis* Rasetti, 1967, from the *Olenellus* (late Lower Cambrian) Zone of the Taconic sequence in Columbia County, New York State and *P. fossula* Resser, 1939, from the *Glossopleura* (Middle Cambrian) Zone of the Lakeview Limestone, Idaho have fewer than six axial pygidial segments. *P. resseri* Kobayashi, 1943, from the *Plagiura–Poliella* (Middle Cambrian) Zone in the Wasatch Mountains, Idaho is distinguished by having a smooth cephalic exoskeleton. *P. walcotti* Rasetti, 1966, known only from the Burgess Shale of British Columbia was described from three poorly preserved specimens and close comparison with it is not possible. This is unfortunate since it appears to be the most closely related species. Pygidial pleural furrows which are obsolete or almost so in *P. ocellata* are well impressed, palpebral furrows, almost obsolete in *P. walcotti*, are well impressed in *P. ocellata*, the pygidial axis is proportionally narrower than in *P. ocellata* and in contrast to that of *P. ocellata* the glabella is not straight sided but tapers forward; these observations serve to distinguish the two species until more information is available on *P. walcotti*.

Clarkson (1966) stated that trilobites possessing schizochroal eyes do not occur in strata older than the Ordovician. He did not elaborate on this statement nor did he account for Opik's (1961, p. 57) description of schizochroal eyes in *Pagetia significans* (Etheridge, 1902). The species described herein also possesses schizochroal eyes confirming that trilobites with that type of eye also lived in the Cambrian Period.

DISTRIBUTION: This species is known only from the Beetle Creek Formation at the type locality.

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